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*Die Physiologische Methodik zur Erforschung der Tierpsyche, ihre Möglichkeit und ihre Anwendung*, von GEORG FR. NICOLAI. Privat-dozent an der Universität, Berlin. Jour. für Psychologie und Neurologie, Oct., 1907. Band X, Heft 1 and 2. S. 1-27.

This paper describes a new method of research in comparative psychology, devised by Prof. Pawlow, Professor of Experimental Medicine in the University at St. Petersburg. The author spent three months in Pawlow's laboratory and has continued the experiments by this method.

The first point discussed by the author of this paper is the "psyche" as a concept of natural science, which he concludes is allowable, but must be strictly limited in its meaning to "the postulated ground of the actions of subjects, which is related to our subjectively felt psyche just as any form of mechanical power is related to muscle power as felt."

The conditions of method in psychology as a natural science are then enumerated. These are universality, constancy, measurability, and specificity. Any bodily function may be taken as an equivalent expression of the psyche, but it must be independent of other influences and especially of the will. Such functions, then, as can be chosen for experimental purposes are blood pressure, pulse, respiration, separation of secretions or similar functions. Numerous experiments have been made with the first three, but the results have failed in the character of specificity. The method of Pawlow is the first to fulfill the four conditions just enumerated and he expressly states that his method is a physiological one and carefully avoids any expressions which might imply that his researches are on mental activities. The reaction chosen by Pawlow was the secretion of saliva and all his experiments were carried out on dogs. The dogs were operated upon in such a way that a salivary gland, *e. g.*, the parotid, was given an opening on the outer side of the cheek. After a few weeks this healed, leaving a permanent outlet, which appeared in no way to disturb the animal or to cause him any inconvenience, so that the reactions may be considered as normal. In order to measure the quantity of the salivary secretion, a glass tube was attached to the opening in the cheek. This very simple method gave a record of the quantity, but not of variations in the rapidity, of the secretion at different instants of the experiment, and a modification of this was, therefore, adopted, which by means of tambours, registered upon a revolving drum, so that both the rapidity and quantity of the salivary reaction were shown graphically. Saliva flows not only when anything edible is brought in contact with the mouth, but also if this is smelled or seen. The ordinary salivary reflexes from contact are practically constant and unchangeable, but under certain conditions, essentially different reflexes appear which are not constant. Pawlow had already demonstrated earlier that whenever saliva flows there is some reason to be found for it in the environment, and this in a sufficient number of cases to make it practically certain that with sufficient knowledge of the condition this reason could be found. These irregular reflexes Pawlow designated as conditioned reflexes. They differ in two points from the unconditioned reflexes: first, they may, under certain circumstances, be excited by any sense impression, and secondly, they are extremely inconstant. If something is placed in a dog's mouth, saliva will flow in all cases, but if food is only shown him or he is allowed to smell it, the salivary reflex may or may not occur. The next problem is to find out under what conditions such reflexes occur and whether they can be experimentally controlled. Although all the laws of salivary secretion are not known, certain laws of the appearance and disap-

pearance of the conditioned reflex have been established in the St. Petersburg laboratory. They are as follows: Every conditioned reflex can be destroyed by repetition. The shorter the time between its repetitions, the quicker the reflex vanishes. The destruction of a conditioned reflex in no way affects other conditioned reflexes which may be present, *e. g.*, the nullifying of a conditioned sight reflex does not affect one of smell. In cases of the vanishing of the reflex, it re-establishes itself after some hours, or, in cases of very frequent repetition, after some days. There is, however, a possibility of re-establishing it immediately by allowing it to become effectual. Thus if sight and smell reflexes to a dry meat powder have disappeared, they return as soon as the animal has been allowed to taste it.

By means of this conditioned salivary reflex a wide range of experiments becomes possible. From the nature of these experiments great care to avoid sources of error is necessary. Since anything in the environment can, under conditions, become the occasion of a conditioned reflex, it is necessary in all cases where experiments are made with conditioned reflexes to have an acute and well trained observer who is capable of distinguishing whether disturbances came from the environment or are due to voluntary or involuntary movements on his own part. Pawlow has carefully taken into consideration these sources of error and impressed upon his students the necessity of care and foresight in the manipulation of all the technique of the experiment, that the dog, which is the subject of the experiment, may not be disturbed by them.

By this method of experiment with due consideration of the possible sources of error the following results have been obtained. It is possible to decide what details of the outer world can become excitants of the dog's brain. In order to test this, any conditioned reflex may be aroused by any stimulus and the maximal change which can be made without destroying the reflex determined. When, *e. g.*, the application of cold to a certain portion of the skin the size of a dollar acts as a conditioned reflex, the saliva flows and the same result occurs when the cold is applied to another circumscribed place. This shows that the cold stimulus is a generalized one over the whole skin and that the reaction of the dog to cold is not finely graded according to the place stimulated. The same is true of heat stimulus. A totally different result is obtained if a mechanical stimulus, *e. g.*, tickling is used. When by the application of a mechanical stimulus to a specified place the reflex is aroused, it may be entirely without effect upon another portion of the skin, thus showing that the dog's reaction to tickling is more finely differentiated according to place. Hard and sharp objects are also clearly distinguished. The analytic capability of the dog's nervous system for acoustic stimuli is also great. It is comparatively easy to accustom dogs to react to a tone of special pitch and quality and not to other tones. It is then also comparatively easy to establish that the absolute hearing of dogs and their musical memory far surpasses that of most human beings. Many dogs—not all, for they vary individually as do human subjects—are able, after days, to recognize a tone which is only one-quarter a tone higher or lower than one previously associated with feeding. Furthermore, dogs also clearly hear this tone in a chord. The author by the expression 'recognizes a tone' does not mean to imply that any process of recognition takes place in the consciousness of the dog but only that different reactions follow different tones, and that, therefore, the dog must possess an organ which distinguishes tones. For instance, the dog may react to a tone associated with feeding by a secretion of ten drops of saliva, to one-quarter of a tone higher by eight drops, to one-

half of a tone higher with four drops, and to a whole tone higher with only one drop, while at a greater interval the reaction entirely vanishes. At a third or an octave he again reacts.

The method was also applied to optic stimuli and tests made of the dog's ability to discriminate form and color. A dog which six months earlier had been used for other optical experiments but had not been experimented upon in the meantime was shown several times daily, when fed, a shining white circle of about 15 cm. diameter, at a distance of 120 cm. This was continued for a month. After the association was thus established he was occasionally shown the circle without being fed, though the regular association with feeding was continued. He was also on the thirty-sixth day, without being fed, shown a square and later a pentagon. At first there was but a slight difference in the reaction to the square and the circle when shown without feeding, but gradually the reaction to the square lessened and on the fourth day practically disappeared, and the reflex to the pentagon which had been shown only twice, also disappeared at the same time. A heptagon was then used and the number of days required for the disappearance of this reflex was considerably greater than in the case of the square and pentagon. When, however, a hexagon was used there was, from the first, no reaction. In this case, the dog seemed without previous experience to refer this form to the no-food group of figures. Pawlow states that he has experimentally established by this method the capability of color discrimination in dogs. Nicolai, however, obtained only negative results in his experiments carried out in the Berlin Physiological Institute, the dogs becoming easily confused when red and green of different degrees of brightness were shown them. He would not, however, on the ground of these experiments dispute Pawlow's results, since there are numerous possibilities of error.

Other experiments have established that the analytical capability of the dog may be heightened in the case of sensations that can be measured. In these experiments temperature and mechanical stimuli were used, *e. g.*, a quick rubbing of the skin (60 strokes per minute causes a larger quantity of saliva to be secreted than a slow stroking (20 strokes per minute). This holds good not only for mechanical and temperature but also for optic and acoustic stimuli. Comparative experiments with the different senses have also been made, *e. g.*, with temperature, mechanical and optical stimuli from which it appears that the tickle stimulus is much stronger and has more significance for the dog's existence than temperature stimuli; also that mechanical are stronger than optical stimuli. Furthermore, newly introduced stimuli may have an inhibitory influence. When, for instance, a new stimulus of the same kind as one already acting is introduced there is an inhibition of the first, *e. g.*, reaction to one odor may be inhibited by the introduction of a second odor, or the introduction of a tone simultaneously with one already acting as stimulus may inhibit the reaction.

The possibility and advantages of this method are easy to discern and Pawlow has made a most important contribution to comparative psychology, for the introduction to which psychologists must be grateful to Dr. Nicolai, as the Russian reports are inaccessible to most readers.

THEODATE L. SMITH.

*The Dancing Mouse*, by ROBERT M. YERKES, PH. D. The Macmillan Company, New York, 1907. pp. 290.

Animal psychology is rapidly passing from the stage of chance observation to the stage of careful experimental investigation. Dr. Yerkes's book is an unusually valuable contribution, and may well